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(54) **CROSS FLOW FAN AND AIR-CONDITIONING APPARATUS INCLUDING SAME**

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B63H 5/07 (2006.01)

(Continued)

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CPC ***F04D 17/04*** (2013.01); ***F01D 5/141*** (2013.01); ***F04D 29/281*** (2013.01); ***F04D 29/283*** (2013.01); ***F04D 29/30*** (2013.01); ***F24F 1/0025*** (2013.01)

(58) **Field of Classification Search**

CPC F04D 17/04; F04D 29/281

USPC 416/178, 188

See application file for complete search history.

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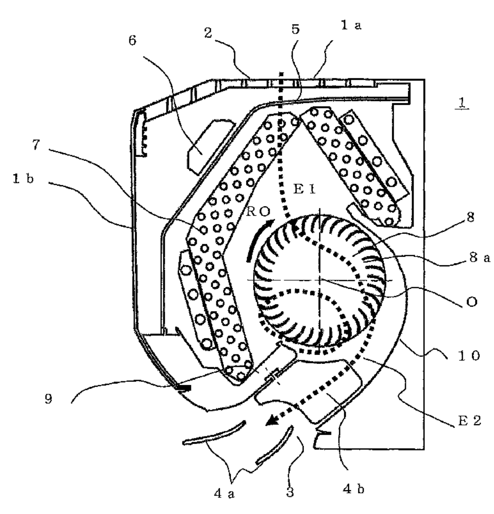
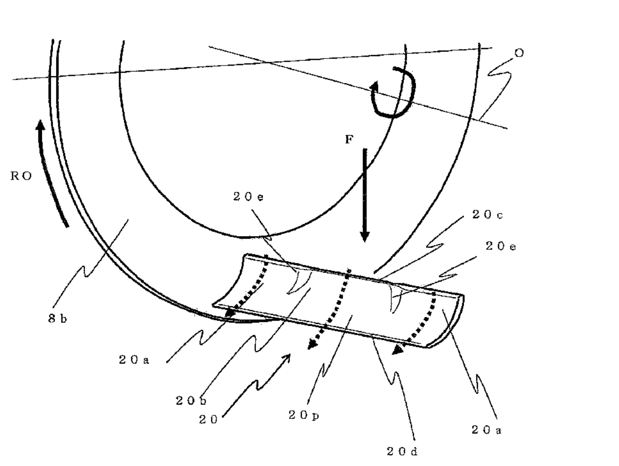
(57) **ABSTRACT**

A cross flow fan including an impeller having at least two rings arranged with intervals in a fan rotation axis O direction and a plurality of blades that are arranged, between correlated rings, with intervals in a circumferential direction of the rings, in which the blade is divided into plural areas in the fan rotation axis O direction, and both ends adjacent to the rings are denoted as the blade-ring proximate sections and the center portion of the blade is denoted as the inter-blade-ring center section. The blade is formed such that the thickness of the inner peripheral blade end of the blade that is the inner peripheral end of the impeller is smaller in the inter-blade-ring center section than in the blade-ring proximate section.

18 Claims, 12 Drawing Sheets





(51) **Int. Cl.**

B64C 11/16	(2006.01)
B64C 27/46	(2006.01)
F01D 5/14	(2006.01)
F03D 11/02	(2006.01)
F04D 17/04	(2006.01)
F04D 29/28	(2006.01)
F24F 1/00	(2011.01)
F04D 29/30	(2006.01)

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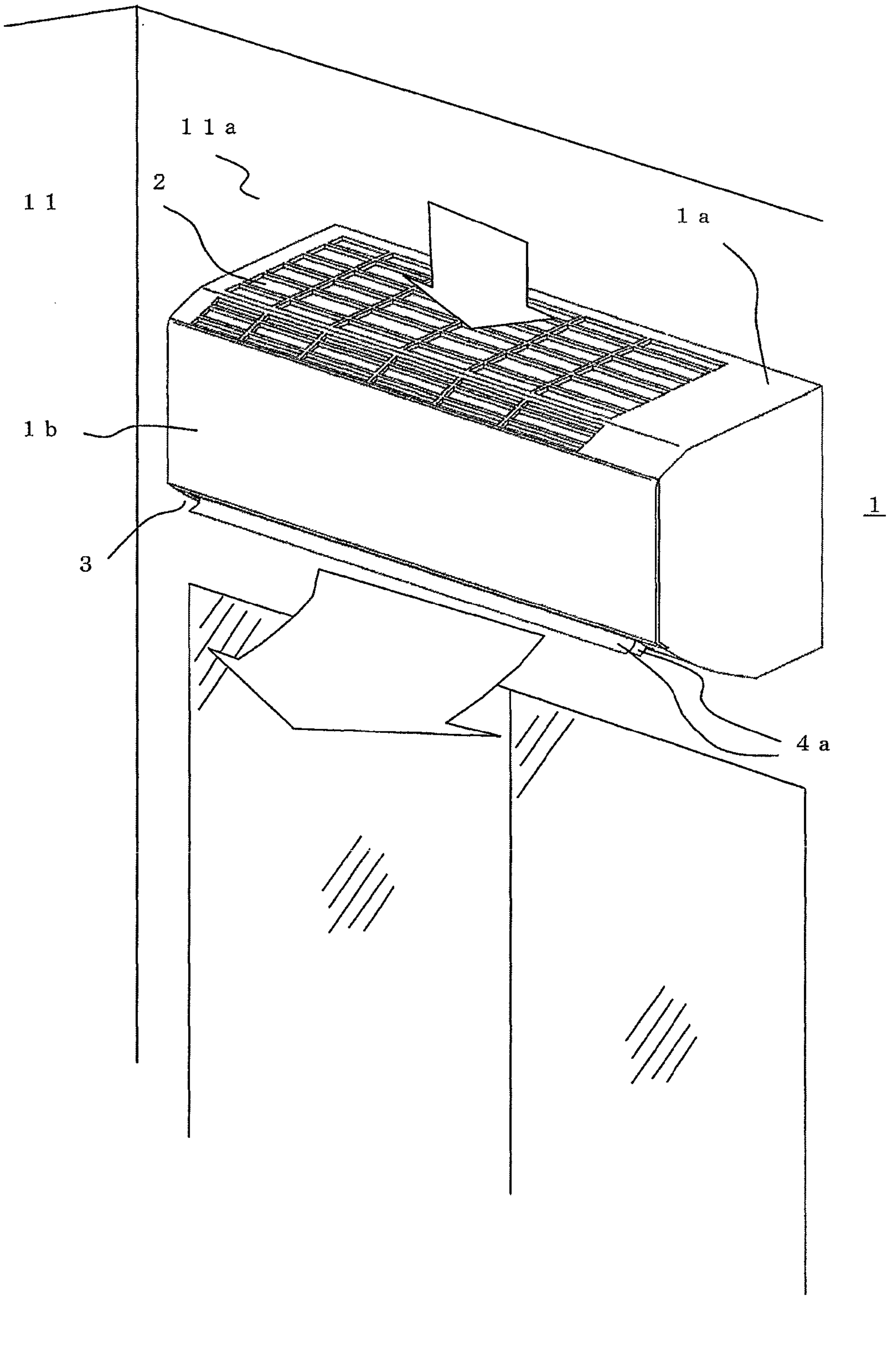
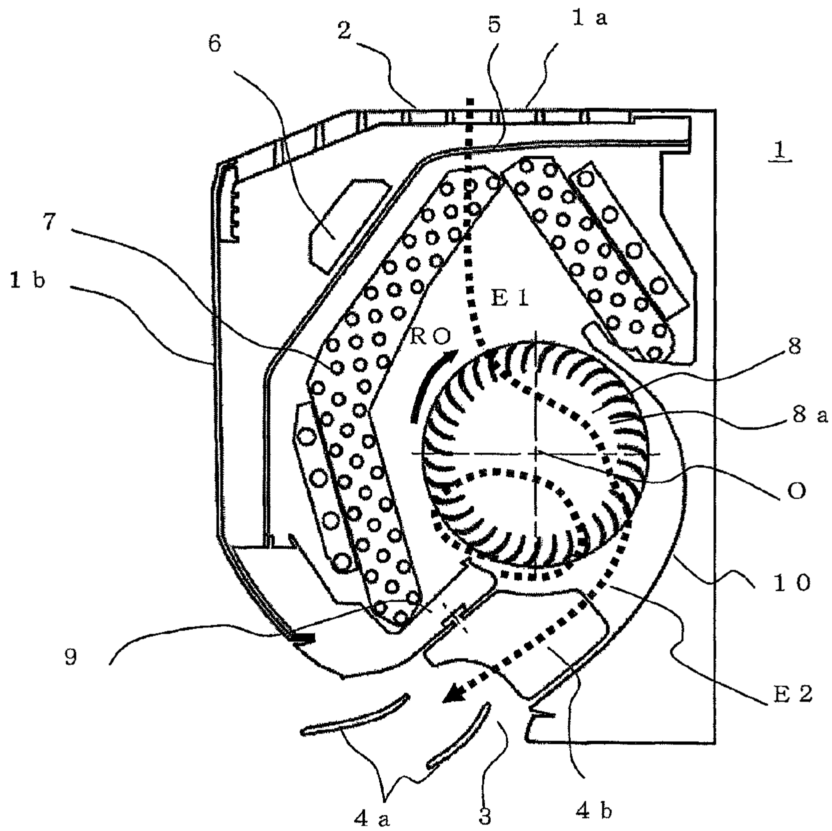
FIG. 1



F I G. 2


6
2
5
1a
1
7
1b
E1
RO
8
8a
O
10
9
E2
4a
3
4b

F I G. 3

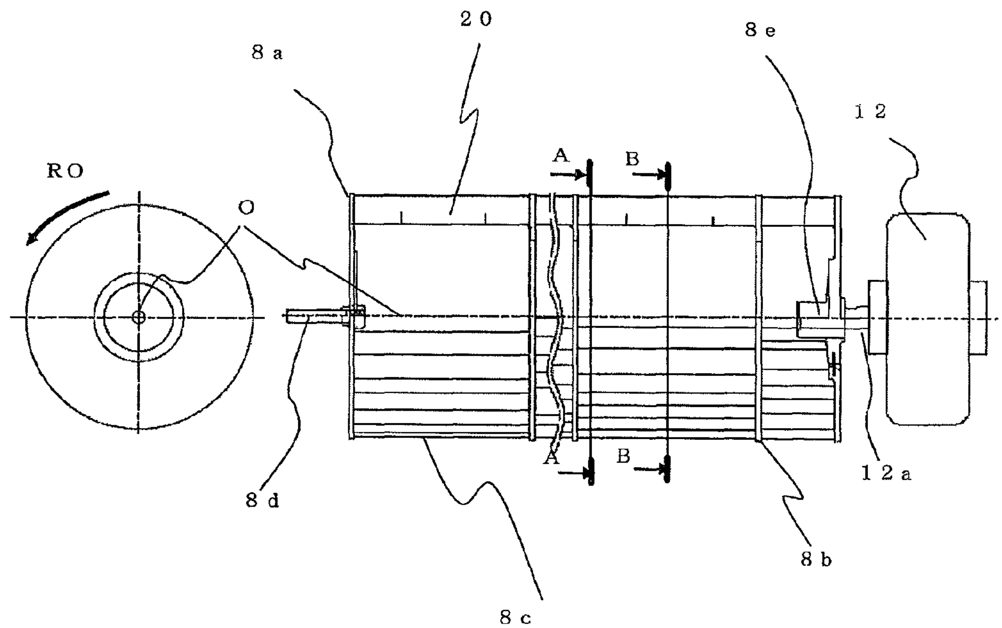

20
8e
8a
12
RO
A
B
O
A
B
8d
12a
8b
8c

FIG. 4

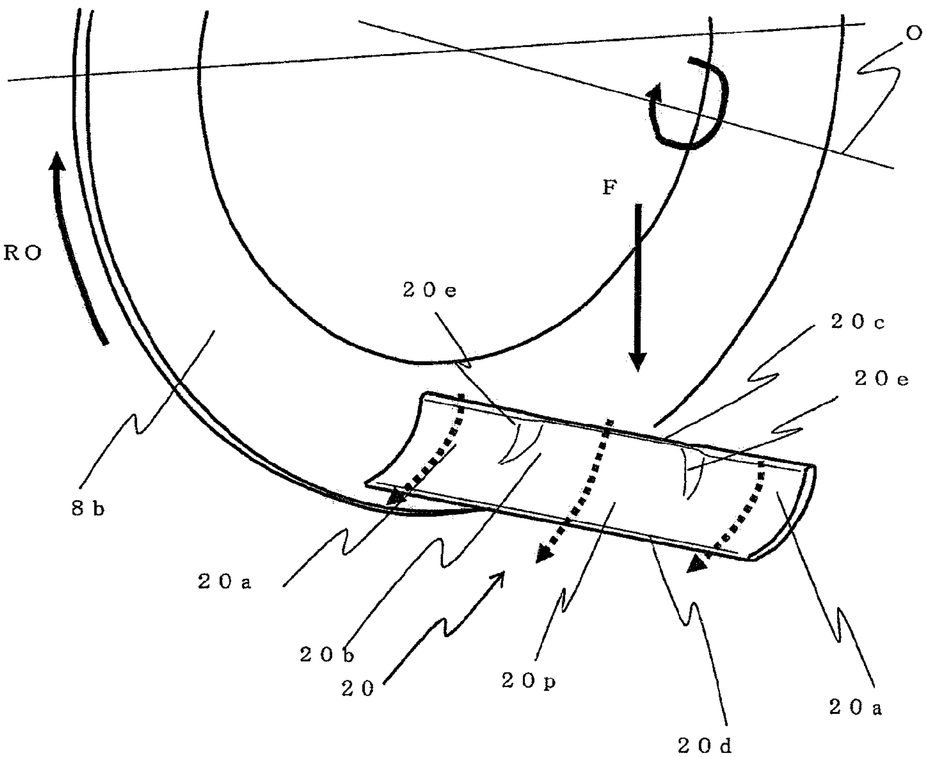
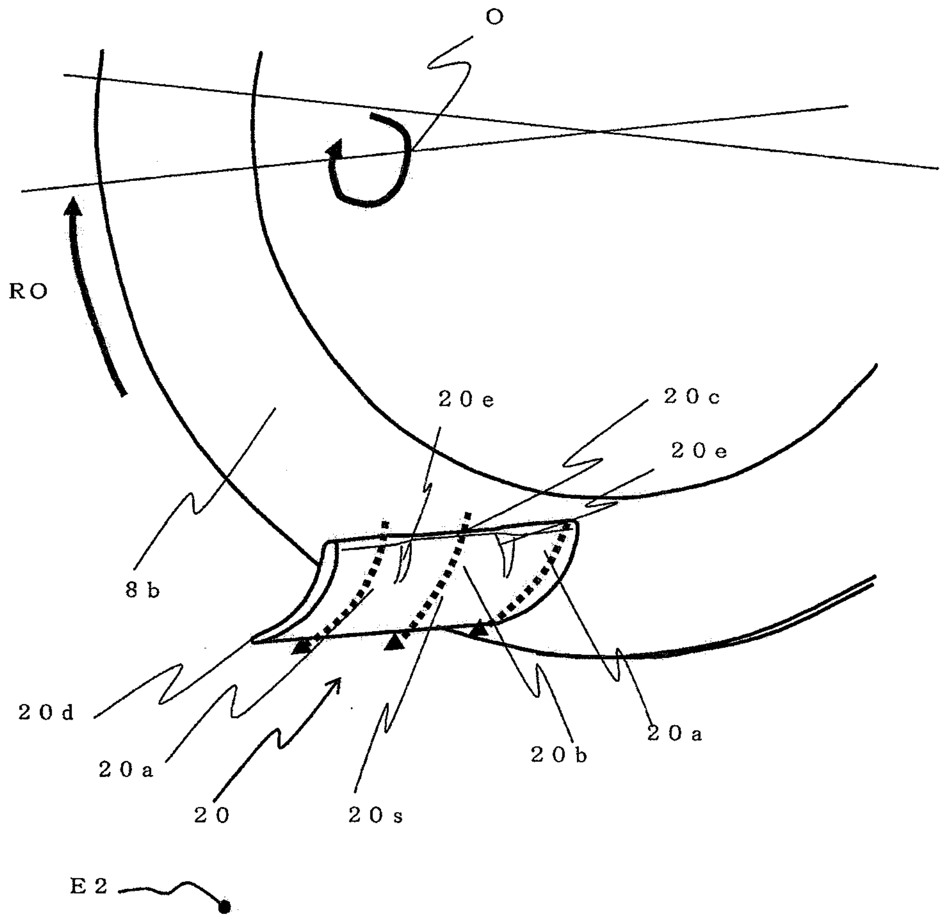


FIG. 5



F I G. 6

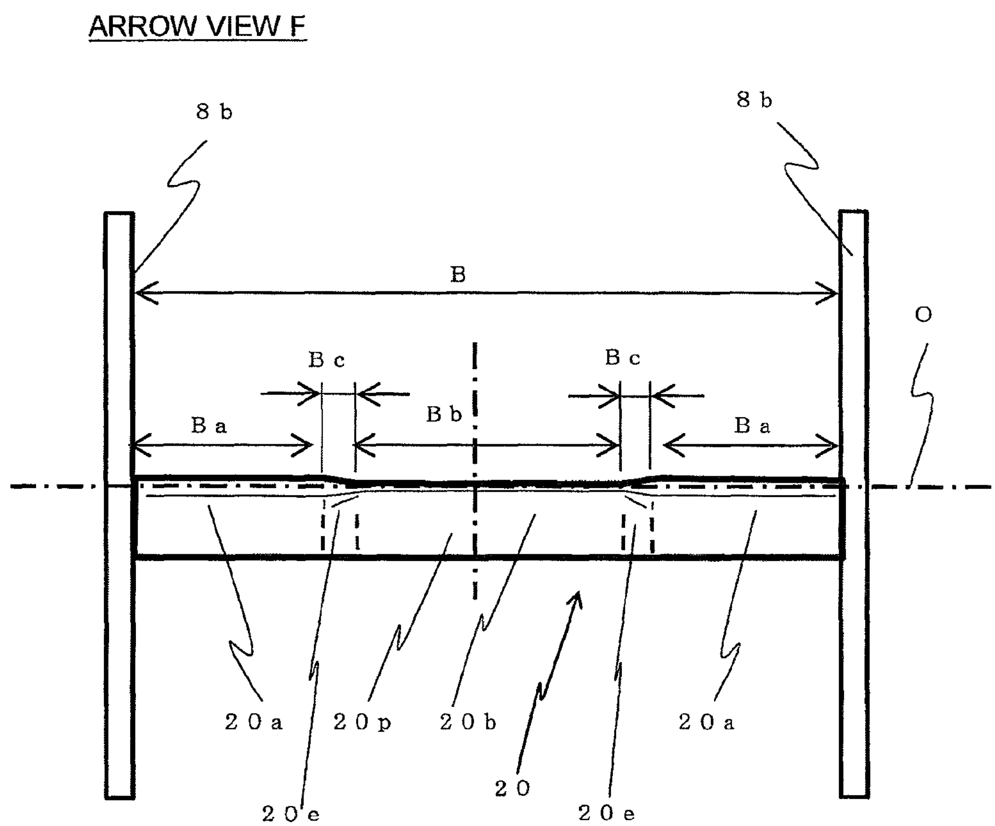


FIG. 7

A—A

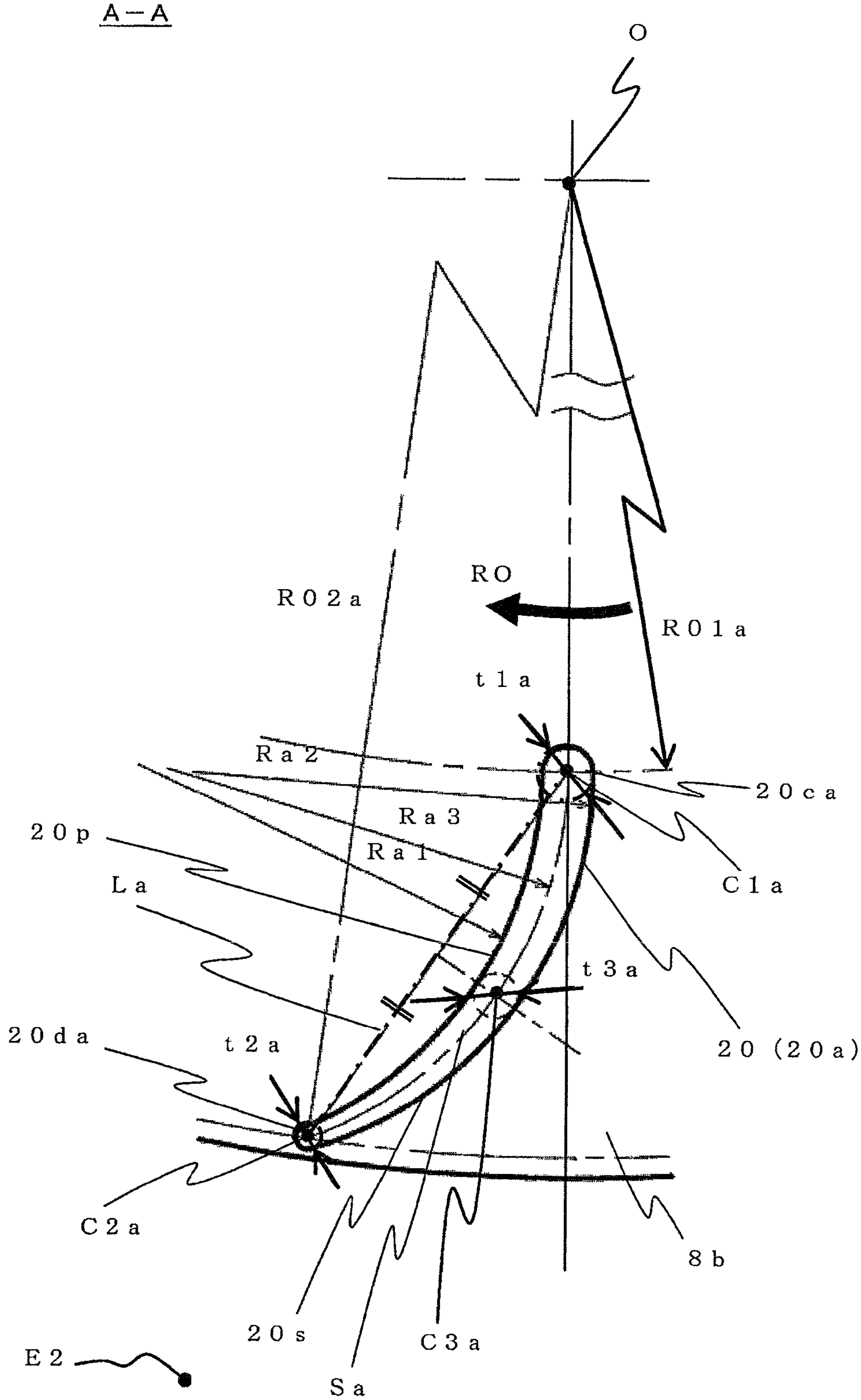

O
RO
R02a
R01a
t1a
Ra2
20ca
Ra3
Ra1
20p
C1a
La
t3a
20(20a)
20da
t2a
C2a
8b
20s
C3a
Sa
E2

FIG. 8

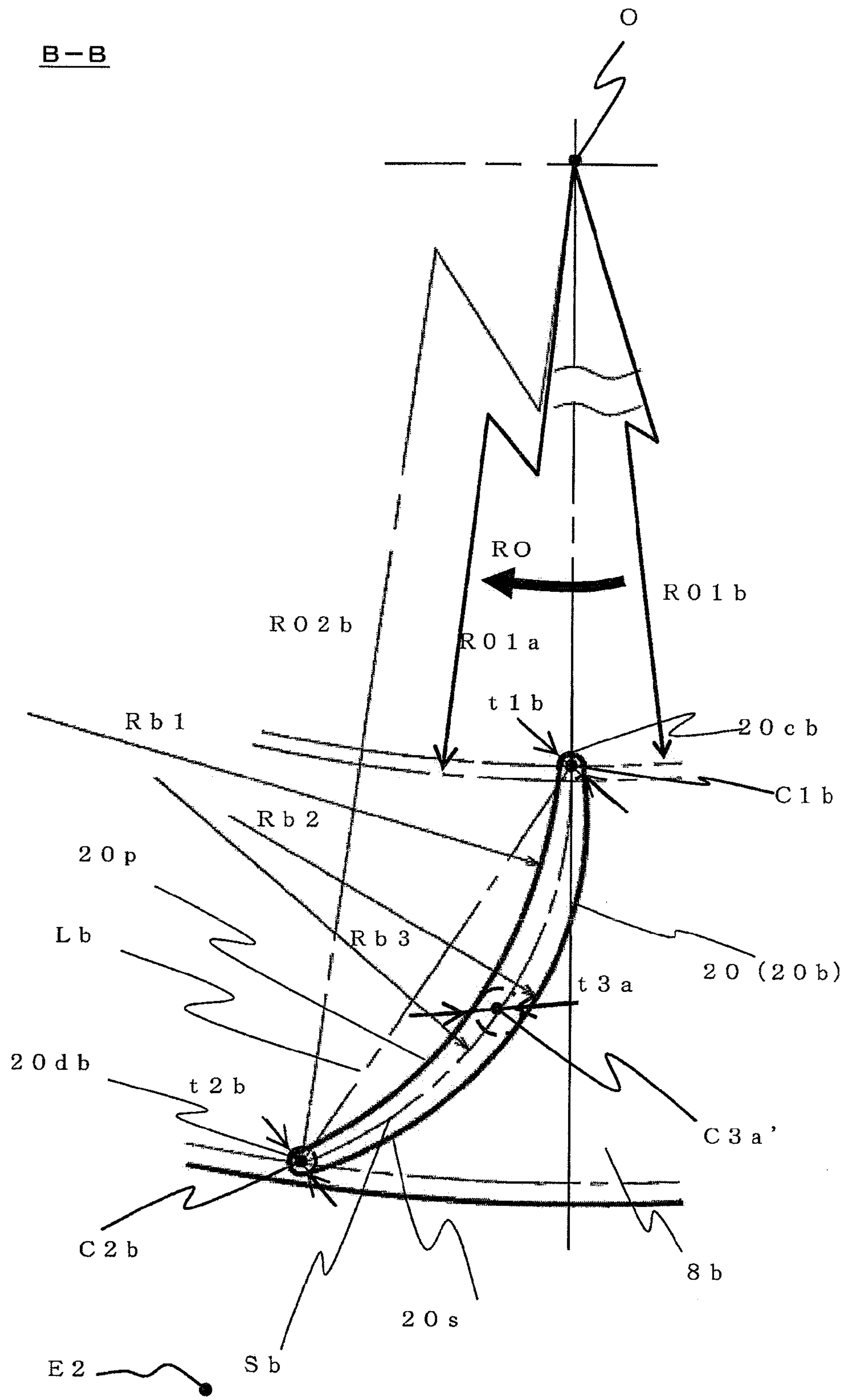

B−B
O
RO
R01b
R02b
R01a
t1b
Rb1
20cb
C1b
Rb2
20p
Lb
Rb3
20 (20b)
t3a
20db
t2b
C3a'
C2b
8b
20s
E2
Sb

FIG. 9

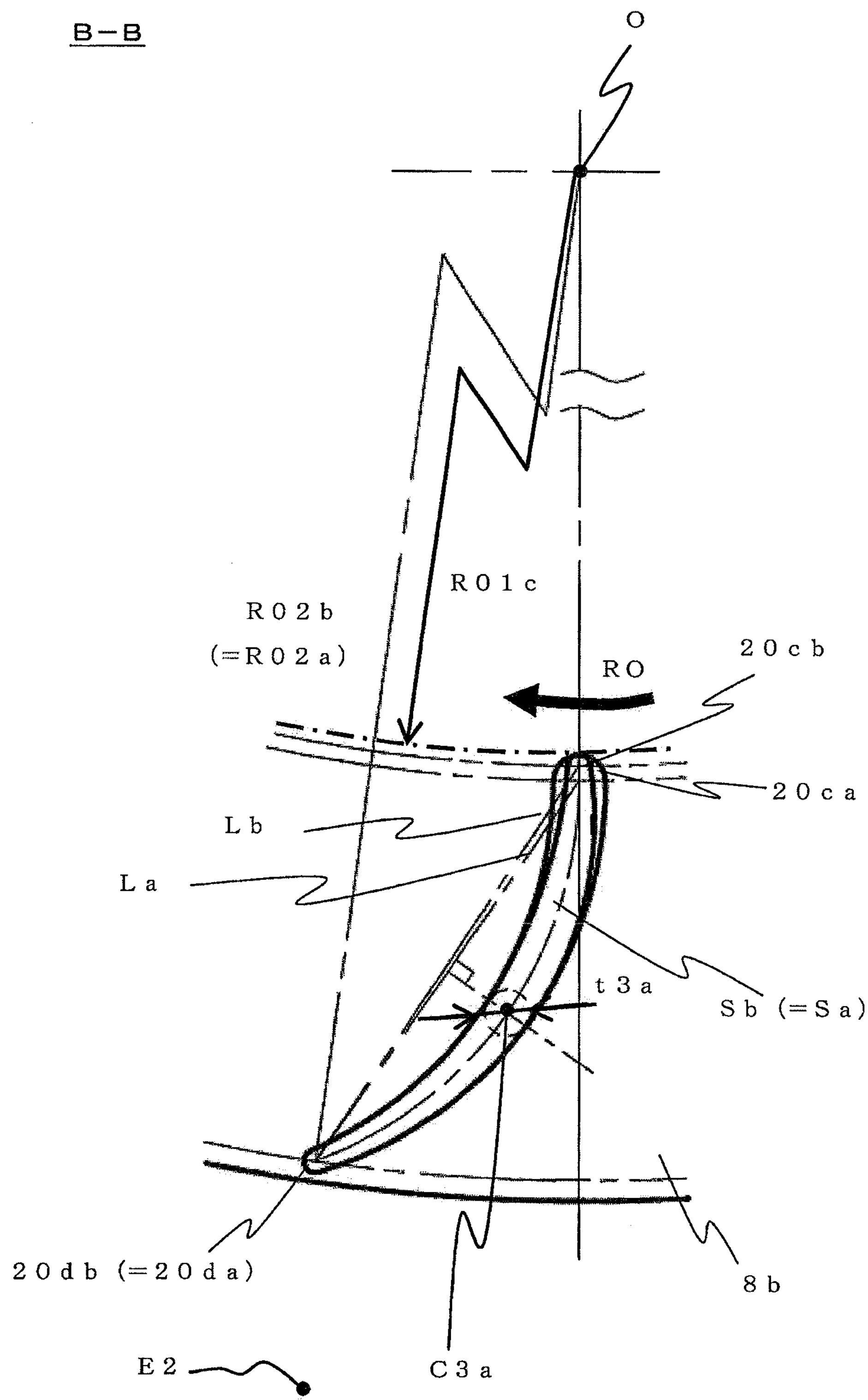

B-B
O
R01c
R02b
(=R02a)
RO
20cb
20ca
Lb
La
t3a
Sb (=Sa)
20db (=20da)
8b
E2
C3a

FIG. 10

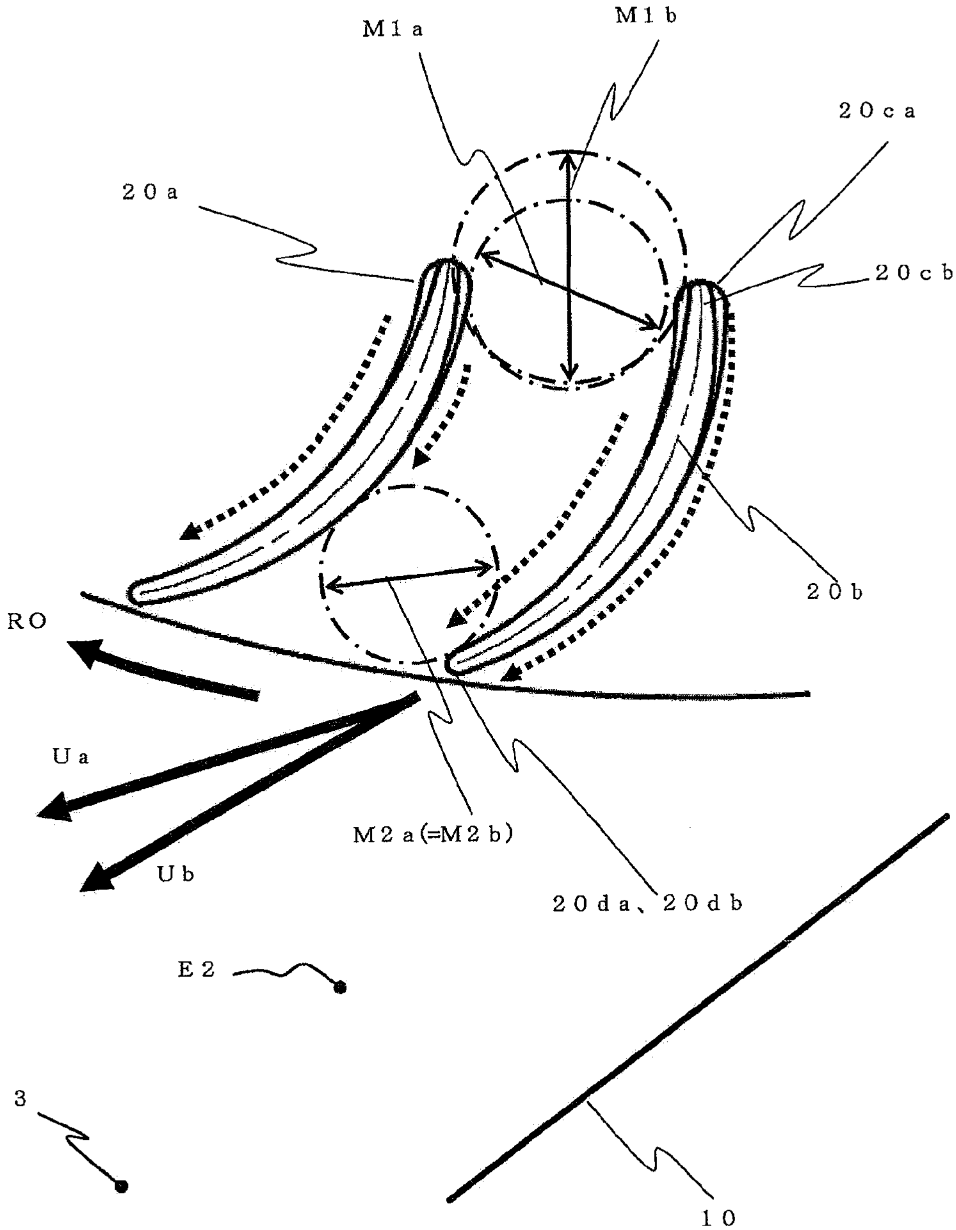


FIG. 11

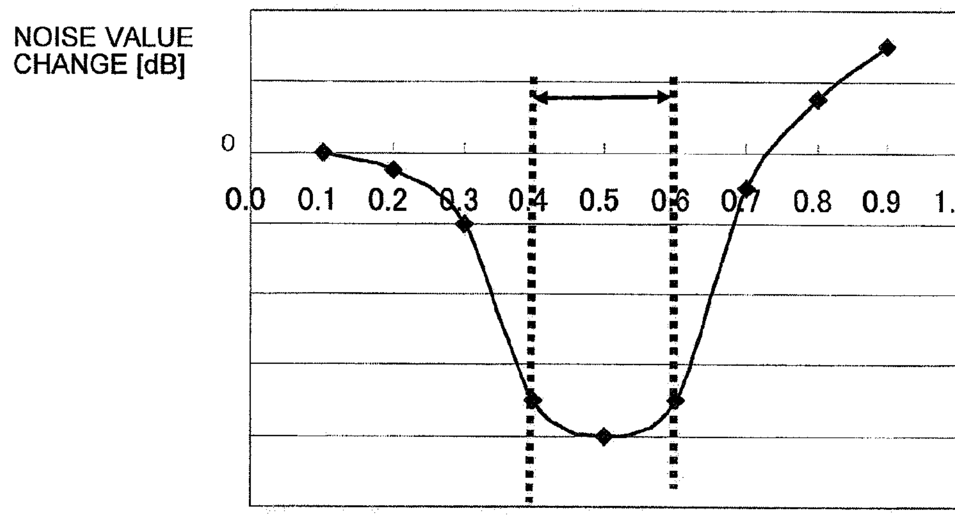

NOISE VALUE
CHANGE [dB]
0
0.0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1.0

FIG. 12

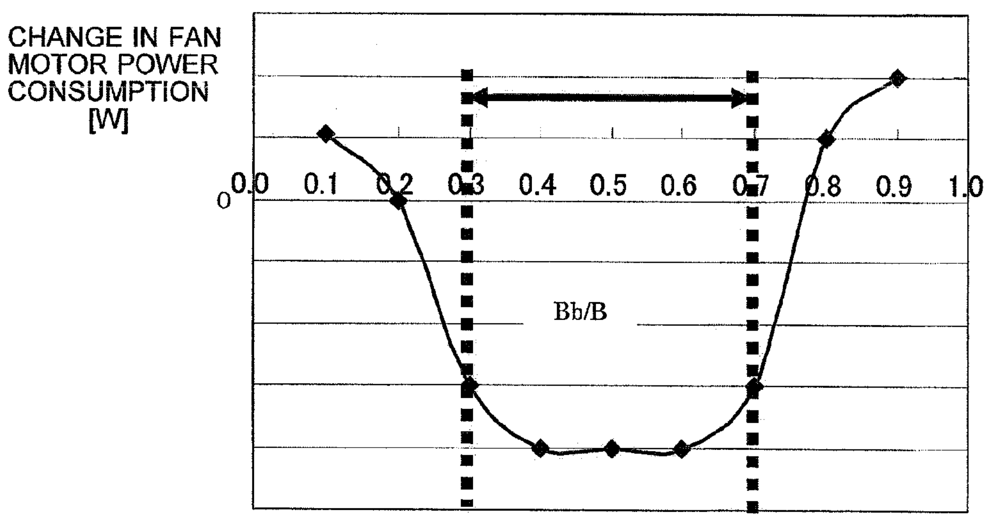

CHANGE IN FAN
MOTOR POWER
CONSUMPTION
[W]
0
0.0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1.0
Bb/B

FIG. 13

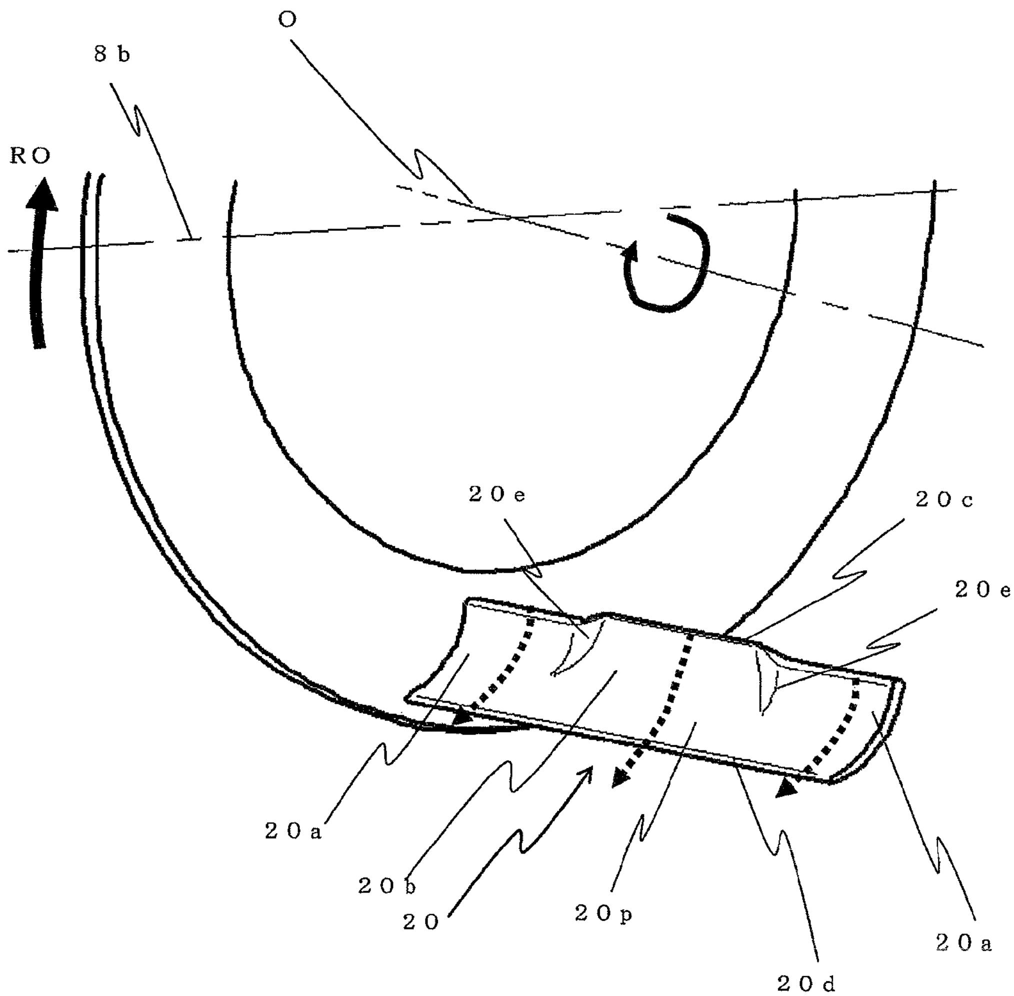
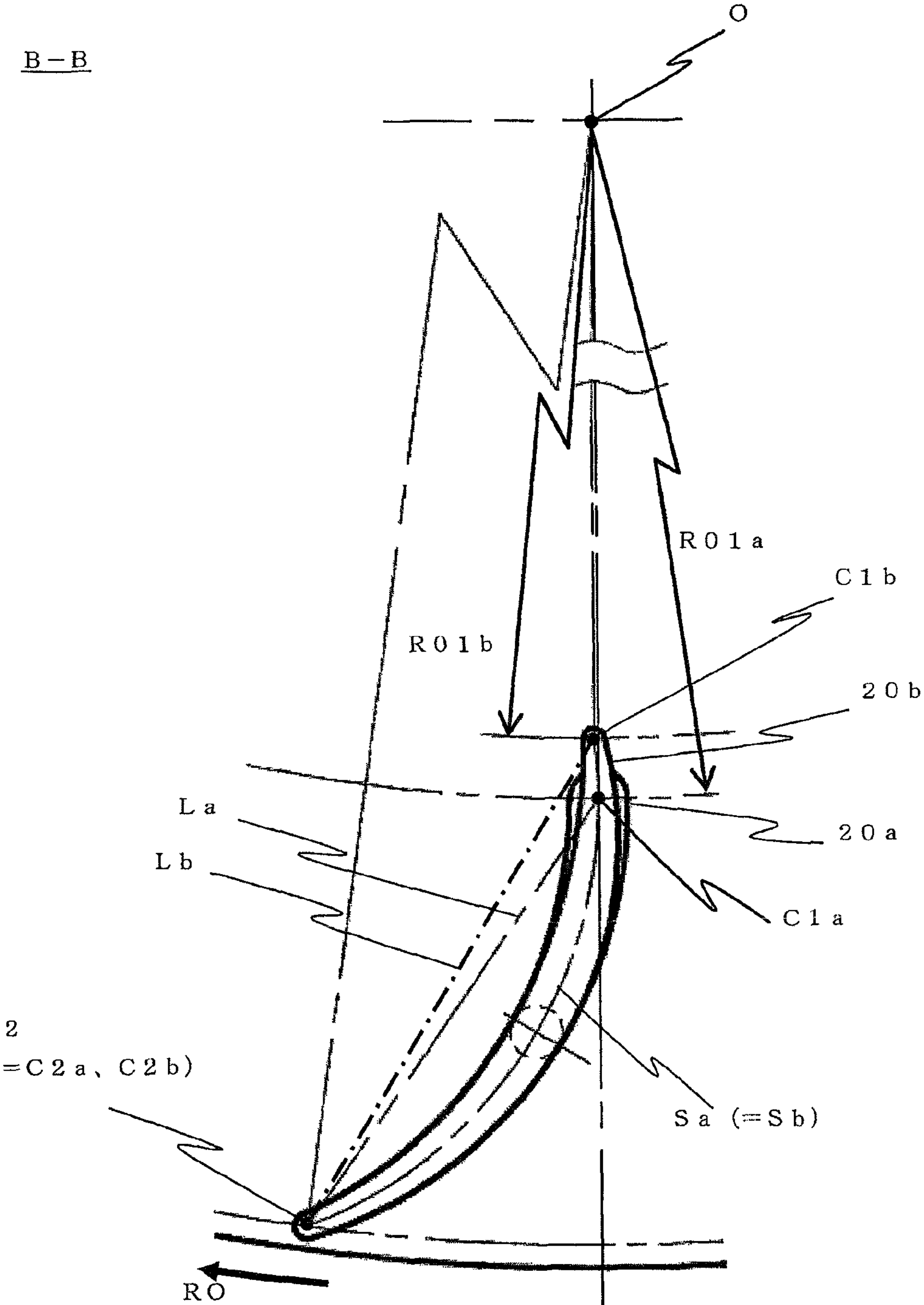


FIG. 14



CROSS FLOW FAN AND AIR-CONDITIONING APPARATUS INCLUDING SAME

CROSS REFERENCE TO RELATED APPLICATIONS

This application is a U.S. national stage application of PCT/JP2011/005717 filed on Oct. 12, 2011, and claims priority to, and incorporates by reference, Japanese Patent Application No. 2010-249511 filed on Nov. 8, 2010.

TECHNICAL FIELD

The present invention relates to a cross flow fan and to an air-conditioning apparatus equipped with such a cross flow fan.

BACKGROUND ART

In conventional cross flow fans, there has been proposed, for example, a cross flow fan in which "the blade shape of the cross flow fan is configured with an arc-shaped portion defining a position of maximum thickness on the inner circumferential side of the blade, and in which a blade shape has a thickness distribution that gradually reduces its thickness towards the outer circumferential direction from the arc-shaped portion" with an object to "form a stable flow field even when a load is applied" (see Patent Literature 1, for example).

Furthermore, there has been proposed, for example, "a traverse fan in which a plurality of blades is arranged in a circumferential direction in an annual manner with a predetermined mounting pitch and is laterally fixed between a pair of discoid or circular end plates, and in which a partition plate is disposed in an intermediate portion of the blade in the axis direction", "the blade being formed such that the chord length in the intermediate portion in the axis direction is shorter than the chord length in the two end portions of the blade in the axis direction" with an object to "effectively lower fan noise without reducing air volume" (see Patent Literature 2, for example).

CITATION LIST

Patent Literature

[Patent Literature 1] Japanese Unexamined Patent Application Publication No. 2001-323891 (paragraphs [0007] and [0008], FIG. 1)

[Patent Literature 2] Japanese Unexamined Patent Application Publication No. 10-77988 (paragraphs [0009] and [0015], FIGS. 1 and 4)

SUMMARY OF INVENTION

Technical Problem

In the cross flow fan described in Patent Literature 1, a intermediate portion of a ring of the discoid blade mounting plate is not influenced by a boundary layer that develops on a surface of the ring; hence, suction and blowing out of air is facilitated.

However, because the blade has the same blade shape in the impeller shaft direction, the inter-blade distance is small, thus creating air flow resistance in the passage between the blades. As such, there has been a problem in that the fanning efficiency is deteriorated.

Further, owing to the deterioration of fanning efficiency, the power consumption of the fan motor driving the impeller increases. As such, there has been a problem in that the cross flow fan is inferior in energy efficiency.

Furthermore, in the cross flow fan described in Patent Literature 2, the blade chord length in the intermediate portion between the rings is formed smaller than the blade chord length in the portion close to the ring in order to reduce the air velocity in the intermediate portion between the rings and make the overall fan air velocity distribution in the shaft direction uniform.

However, because the chord length is made short in the area where it is easier for the air to flow through, such as the intermediate portion between the rings where there is no obstacles such as a ring, there has been a problem in that the blast volume drops.

That is, because the air velocity distribution in the impeller shaft direction is made uniform by reducing the pressure rise in the blades, there has been a problem in that the fanning efficiency deteriorates.

Further, owing to the deterioration of fanning efficiency, the power consumption of the fan motor driving the impeller increases. As such, there has been a problem in that the cross flow fan is inferior in energy efficiency.

The invention is addressed to overcome the problems described above and provides a cross flow fan that is capable of reducing the air flow resistance in the passage between the blades, as well as an air-conditioning apparatus equipped with this cross flow fan.

Further, the invention provides a cross flow fan that is capable of making the air velocity distribution of the impeller uniform, as well as an air-conditioning apparatus equipped with this cross flow fan.

Furthermore, the invention provides a cross flow fan that is capable of reducing air flow resistance in the impeller and the air passage and that is capable of improving fanning efficiency, as well as an air-conditioning apparatus equipped with this cross flow fan.

Additionally, the invention provides a cross flow fan that is capable of suppressing increase in power consumption of the fan motor driving the impeller and that is capable of improving energy efficiency, as well as an air-conditioning apparatus equipped with this cross flow fan.

Solution to Problem

The cross flow fan according to the invention includes an impeller having at least two support plates arranged with intervals in a rotation axis direction; and a plurality of blades arranged between correlated support plates, the blades being arranged with intervals in a circumferential direction of the support plates, in which each blade between the support plates is divided into a plurality of areas in the rotation axis direction such that both ends adjacent to the support plates are a first area and a center portion of the blade is a second area, and a thickness of an inner peripheral blade end that is an end of a blade on an inner-circumferential side of the impeller is formed such that the second area is smaller in thickness than the first area

The air-conditioning apparatus according to the invention includes the above described cross flow fan; and an heat exchanger disposed in a suction-side passage formed by the cross flow fan, the heat exchanger being configured to exchange heat with sucked-in air.

Advantageous Effects of Invention

In the invention, the thickness of the inner peripheral blade end of the blade is formed smaller in the second region, which is the middle portion, than in the first region, which is adjacent to the support plate; hence, it is possible to reduce the air flow resistance in each passage between the blades.

Further, it is possible to make the air velocity distribution of the impeller uniform.

Furthermore, it is possible to reduce the air flow resistance in the impeller and the air passage, thus improve fanning efficiency.

Moreover, it is possible to suppress increase in power consumption of the fan motor driving the impeller, thus improve energy efficiency.

BRIEF DESCRIPTION OF DRAWINGS

FIG. **1** is an external perspective view of an air-conditioning apparatus according to Embodiment 1 of the invention.

FIG. **2** is a longitudinal sectional view of the air-conditioning apparatus of FIG. **1**.

FIG. **3** is a front view of an impeller of a cross flow fan of FIG. **1**.

FIG. **4** is a perspective view of a single blade of FIG. **3** seen from a blade pressure surface side (rotation direction side).

FIG. **5** is a perspective view of the single blade of FIG. **3** seen from a blade suction pressure surface side (opposite the rotation direction side).

FIG. **6** is an arrow view of the single blade of FIG. **4** taken from the direction of arrow F seen from an inner circumferential side of the fan.

FIG. **7** is a cross-sectional view of the single blade of FIG. **3** taken along the line A-A.

FIG. **8** is a cross-sectional view of the single blade of FIG. **3** taken along the line B-B.

FIG. **9** is a cross-sectional view of the single blade of FIG. **3** taken along the line B-B.

FIG. **10** is an enlarged view of a cross-sectional view of a plurality of blades of FIG. **3** on the fan outlet side taken along the line A-A.

FIG. **11** is a diagram illustrating a noise value change in relation to a ratio Bb/B of a length Bb of an inter-blade-ring center section to an inter-blade-ring length B, under a constant air volume.

FIG. **12** is a diagram illustrating change in fan motor power consumption in relation to the ratio Bb/B under a constant air volume.

FIG. **13** is a perspective view of a cross flow fan of Embodiment 2 that corresponds to that of FIG. **4** and that is mounted to an air-conditioning apparatus.

FIG. **14** is a cross-sectional view of the blade of FIG. **13** corresponding to that of FIG. **9** taken along the line B-B.

DESCRIPTION OF EXEMPLARY EMBODIMENTS

First Exemplary Embodiment

FIG. **1** is an external perspective view of an air-conditioning apparatus according to Embodiment 1 of the invention.

FIG. **2** is a longitudinal sectional view of the air-conditioning apparatus of FIG. **1**.

Referring to FIGS. **1** and **2**, an air-conditioning apparatus body **1** according to the invention is disposed on a wall **11***a* of a room **11** to be air-conditioned.

Further, a detachable front grille **6** is attached to a body front **1***a*.

Furthermore, an upper inlet port **2**, a filter **5** that carries out dust removal of dust, and a heat exchanger **7** that carries out cooling/heating by exchanging heat with air suctioned into the body are arranged in the body upper portion **1***b*.

A cross flow fan **8** that is an air-sending device is arranged on the downstream side of the heat exchanger **7**.

The cross flow fan **8** includes an impeller **8***a*; a stabilizer **9** having a tongue portion, which separates a suction side flow path E**1** and a discharge side flow path E**2**, and a drain pan, which temporarily stores water droplets dripping from the heat exchanger **7**; and a helical guide wall **10** on the discharge side of the impeller **8***a*.

Furthermore, air direction vanes (vertical wind direction vanes **4***a* and horizontal wind direction vanes **4***b*) are rotatably attached to the air outlet **3**.

FIG. **3** is a front view of the impeller of the cross flow fan of FIG. **1**.

Referring to FIG. **3**, the impeller **8***a* of the cross flow fan **8** is, as an example, formed of thermoplastic resin such as AS resin.

The impeller **8***a* is integrally formed by welding and connecting a plurality of impeller units **8***c* that includes a plurality of blades **20** that extends from the outer circumference of a disk-shaped ring **8***b* and that is consecutively installed in the circumferential direction of the ring **8***b*.

That is, the plurality of blades **20** that are arranged with intervals in the circumferential direction of the rings **8***b* are provided between the correlated rings **8***b* of the impeller unit **8***c*.

Furthermore, the impeller **8***a* sends air by moving rotationally in a fan rotation direction RO with a fan rotation axis O at its center while the two ends are in a supported state such that one end is secured to a fan shaft **8***d* and the other end is secured by a screw and the like to a fan boss **8***e*, which protrudes into the internal side of the impeller **8***a*, and a motor shaft **12***a* of a motor **12**.

Note that the "ring **8***b*" corresponds to a "support plate" of the invention.

Note that, in Embodiment 1, although the impeller **8***a* is formed by connecting a plurality of impeller units **8***c*, the invention is not limited to this and the impeller **8***a* may be constituted by an impeller unit **8***c* alone.

Note that, in Embodiment 1, although disk-shaped rings **8***b* are used, the invention is not limited to this. For example, polygonal support plates may be used.

FIG. **4** is a perspective view of a single blade of FIG. **3** seen from a blade pressure surface side (rotation direction side).

FIG. **5** is a perspective view of the single blade of FIG. **3** seen from a blade suction pressure surface side (opposite the rotation direction side).

FIG. **6** is an arrow view taken from the direction of arrow F showing the single blade of FIG. **4** from an inner circumferential side of the fan.

Referring to FIGS. **4** to **6**, the blade **20** is formed with a shape in which its outer peripheral blade end **20***d*, which is the outer peripheral end of the impeller **8***a*, is tilted forward in the fan rotation direction RO relative to its inner peripheral blade end **20***c*, which is the inner peripheral end of the impeller **8***a*.

The blade **20** is divided into plural areas in the rotation axis direction such that five areas are formed, namely, blade-ring proximate sections **20***a* that are both end portions adjacent to the rings **8***b*, inter-blade-ring center section **20***b* that is the center portion of the blade **20**, and blade connection sections **20***e* that are areas between the blade-ring proximate sections **20***a* and the inter-blade-ring center section **20***b*.

Note that the "blade-ring proximate sections **20***a*" corresponds to a "first area" of the invention.

Note that the "inter-blade-ring center section **20***b*" corresponds to a "second area" of the invention.

Note that the "blade connection sections 20e" corresponds to a "third area" of the invention.

Regarding the thickness of the inner peripheral blade end 20c of the blade 20, the inter-blade-ring center section 20b is formed thinner than the blade-ring proximate sections 20a.

Furthermore, the thickness of the blade 20 in the blade connection sections 20e is formed to gradually change in shape from the thickness of the blade-ring proximate sections 20a to the thickness of the inter-blade-ring center section 20b.

That is, the inner peripheral blade end 20c of the blade 20 is formed such that both a blade pressure surface 20p, which is the front surface of the blade 20 with respect to the fan rotation direction RO, and a blade suction pressure surface 20s, which is the rear surface with respect to the fan rotation direction RO, are dented in the inter-blade-ring center section 20b for a predetermined length in the fan rotation axis O direction.

Furthermore, as shown in FIG. 6, in an inter-blade-ring length B that is the total length of the blade 20 in the fan rotation axis O direction, a length Bb of the inter-blade-ring center section 20b in the fan rotation axis O direction, each length Ba of the two blade-ring proximate sections 20a at both ends in the fan rotation axis O direction, and each length Bc of the two blade connection sections 20e in the fan rotation axis O direction hold a relationship of Bb>Ba>Bc.

FIG. 7 is a cross-sectional view taken along the line A-A of the single blade of FIG. 3.

Referring to FIG. 7, a section of a blade-ring proximate section 20a that is orthogonal to the fan rotation axis O is shown.

As shown in FIG. 7, the blade 20 is formed such that its section orthogonal to the fan rotation axis O has an arc shape.

An outer peripheral blade end 20da and an inner peripheral blade end 20ca in the blade-ring proximate section 20a of the blade 20 are both formed into an arc shape. Further, the outer peripheral blade end 20da is positioned on the inner circumferential side relative to the outer circumference of the ring 8b.

Furthermore, the thickness of the blade 20 in the blade-ring proximate section 20a is formed to gradually increase from the outer peripheral blade end 20da to the inner peripheral blade end 20ca.

That is, when t1a is the thickness at an arc center point C1a of the inner peripheral blade end 20ca in the blade-ring proximate section 20a, t2a is the thickness at an arc center point C2a of the outer peripheral blade end 20da, and t3a is the thickness at the chord center point C3a (described later), the thickness in the blade-ring proximate section 20a is formed such that: thickness t2a of the outer peripheral blade end 20da<thickness t3a at the chord center point C3a<thickness t1a of the inner peripheral blade end 20ca.

Here, the thickness t1a of the inner peripheral blade end 20ca corresponds to the diameter of a circle that inscribes the arc of the inner peripheral blade end 20ca.

Further, the thickness t2a of the outer peripheral blade end 20da corresponds to the diameter of a circle that inscribes the arc of the outer peripheral blade end 20da.

Furthermore, when a chord line La is the line connecting the arc center point C2a of the outer peripheral blade end 20da and the arc center point C1a of the inner peripheral blade end 20ca, the thickness t3a at the chord center point C3a corresponds to the diameter of a circle inscribing the blade 20 at the chord center point C3a that is an intersection point between a perpendicular bisector of this chord line La and a camber line Sa that is the center line of thickness of the blade 20 in the blade-ring proximate section 20a.

The blade pressure surface 20p, the camber line Sa, and the blade suction pressure surface 20s are each formed into an arc shape in a section of the blade-ring proximate section 20a orthogonal to the fan rotation axis O.

Furthermore, when Ra1 is the arc radius of the blade pressure surface 20p, Ra2 is the arc radius of the blade suction pressure surface 20s, and Ra3 is the arc radius of the camber line Sa, then, the blade 20 is formed such that: the arc radius Ra1 of the blade pressure surface 20p<the arc radius Ra3 of the camber line Sa<the arc radius Ra2 of the blade suction pressure surface 20s.

That is, the arc radius Ra1 of the blade pressure surface 20p is formed so as to be smaller than the arc radius Ra2 of the blade suction pressure surface 20s, and the blade 20 is shaped such that the arc radius becomes smaller and the curvature becomes tighter the more on the blade pressure surface 20p side.

Note that in FIG. 7, R01a is the radius of a circle that is centered around the fan rotation axis O and that passes through the arc center point C1a of the inner peripheral blade end 20ca in the blade-ring proximate section 20a.

Furthermore, R02a is the radius of a circle that is centered around the fan rotation axis O and that passes through the arc center point C2a of the outer peripheral blade end 20da in the blade-ring proximate section 20a.

FIG. 8 is a cross-sectional view of the single blade of FIG. 3 taken along the line B-B.

Referring to FIG. 8, a section of the inter-blade-ring center section 20b that is orthogonal to the fan rotation axis O is shown.

As shown in FIG. 8, the blade 20 is formed such that its section orthogonal to the fan rotation axis O is an arc shape.

An outer peripheral blade end 20db and an inner peripheral blade end 20cb in the inter-blade-ring center section 20b of the blade 20 are both formed into an arc shape. Further, the outer peripheral blade end 20db is positioned on the inner circumferential side relative to the outer circumference of the ring 8b.

Furthermore, the thickness of the blade 20 in the inter-blade-ring center section 20b is formed to gradually increase from the outer peripheral blade end 20db to the middle of the outer peripheral blade end 20db and the inner peripheral blade end 20cb and to gradually decrease from this middle portion to the inner peripheral blade end 20cb.

That is, when t1b is the thickness at an arc center point C1b of the inner peripheral blade end 20cb in the inter-blade-ring center section 20b, t2b is the thickness at an arc center point C2b of the outer peripheral blade end 20db, and t3a is the thickness at the chord center point C3a' (described later), the thickness of the blade 20 in the inter-blade-ring center section 20b is formed, for example, such that: thickness t2b of the outer peripheral blade end 20db<the thickness t3a at the chord center point C3a', and, the thickness t3a at the chord center point C3a'>thickness t1b of the inner peripheral blade end 20cb.

Here, the thickness t1b of the inner peripheral blade end 20cb corresponds to the diameter of a circle that inscribes the arc of the inner peripheral blade end 20cb.

Further, the thickness t2b of the outer peripheral blade end 20db corresponds to the diameter of a circle that inscribes the arc of the outer peripheral blade end 20db.

Furthermore, the chord center point C3a' is a projected point of the chord center point C3a in the section of FIG. 7 taken along the line A-A onto the section taken along the line B-B. The thickness t3a at the chord center point C3a' corresponds to the diameter of a circle inscribing the blade 20 at the chord center point C**3**_a_' and is the same as the thickness t**3**_a_ at the chord center point C**3**_a_ in the section of FIG. **7** taken along the line A-A.

Note that although in Embodiment 1, a case is given in which the thickness t**3**_a_ at the chord center point C**3**_a_', which is a projected point of the chord center point C**3**_a_ in the section of FIG. **7** taken along the line A-A onto the section taken along the line B-B, is the thickest and the thickness is the same as that of the section taken along the line A-A, the invention is not limited to this case.

Note that in FIG. **8**, Lb is a chord line connecting the arc center point C**2**_b_ of the outer peripheral blade end **20**_db_ and the arc center point C**1**_b_ of the inner peripheral blade end **20**_cb_.

Further, Sb is a camber line that is the center line of thickness of the blade **20** in the inter-blade-ring center section **20**_b_.

Further, R**01**_b_ is the radius of a circle that is centered around the fan rotation axis O and that passes through the arc center point C**1**_b_ of the inner peripheral blade end **20**_cb_ in the inter-blade-ring center section **20**_b_.

Furthermore, R**02**_b_ is the radius of a circle that is centered around the fan rotation axis O and that passes through the arc center point C**2**_b_ of the outer peripheral blade end **20**_db_ in the inter-blade-ring center section **20**_b_.

The blade pressure surface **20**_p_, the camber line Sb, and the blade suction pressure surface **20**_s_ are each formed into an arc shape in a section of the inter-blade-ring center section **20**_b_ orthogonal to the fan rotation axis O.

Furthermore, when Rb**1** is the arc radius of the blade pressure surface **20**_p_, Rb**2** is the arc radius of the blade suction pressure surface **20**_s_, and Rb**3** is the arc radius of the camber line Sb that is the center line of thickness of the blade **20** in the inter-blade-ring center section **20**_b_, then, the blade **20** is formed such that: the arc radius Rb**1** of the blade pressure surface **20**_p_>the arc radius Rb**3** of the camber line Sb>the arc radius Rb**2** of the blade suction pressure surface **20**_s_.

That is, the arc radius Rb**1** of the blade pressure surface **20**_p_ is formed so as to be larger than the arc radius Rb**2** of the blade suction pressure surface **20**_s_, and the blade **20** is shaped such that the arc radius becomes smaller and the curvature becomes tighter the more on the blade suction pressure surface **20**_s_ side.

FIG. **9** is a cross-sectional view of the single blade of FIG. **3** taken along the line B-B.

Referring to FIG. **9**, a shape of the blade-ring proximate section **20**_a_ is shown, as well as a section of the inter-blade-ring center section **20**_b_ that is orthogonal to the fan rotation axis O.

As shown in FIG. **9**, the blade **20** is formed such that the shapes of the blade-ring proximate section **20**_a_ and the inter-blade-ring center section **20**_b_ are the same from the outer peripheral blade end **20**_d_ to the middle of the outer peripheral blade end **20**_d_ and the inner peripheral blade end **20**_c_.

Furthermore, the blade **20** is formed such that the shapes of the blade-ring proximate section **20**_a_, the inter-blade-ring center section **20**_b_, and the blade connection sections **20**_e_ vary from the middle of the outer peripheral blade end **20**_d_ and the inner peripheral blade end **20**_c_ to the inner peripheral blade end **20**_c_.

For example, the shape of each section is formed so as to be the same from the outer peripheral blade end **20**_d_ to the chord center point C**3**_a_, and the shape of each section is formed so as to vary from the chord center point C**3**_a_ to the inner peripheral blade end **20**_c_.

Furthermore, R**01**_c_ is a radius of a circle that is centered around the fan rotation axis O and that passes through an end face of the inner peripheral blade end **20**_cb_ in the inter-blade-ring center section **20**_b_. R**01**_c_ is the same as the radius of a circle that is centered around the fan rotation axis O and that passes through an end face of the inner peripheral blade end **20**_ca_ in the blade-ring proximate section **20**_a_.

Moreover, the blade **20** is formed such that the camber line Sa, which is the center line of thickness of the blade **20** in the blade-ring proximate section **20**_a_, and the camber line Sb, which is the center line of thickness in the inter-blade-ring center section **20**_b_, are the same.

FIG. **10** is an enlarged view of a cross-sectional view of the plurality of blades of FIG. **3** on the fan outlet side taken along the line A-A.

As shown in FIG. **10**, when a distance between the adjacent blades **20** is depicted by the diameter of a circle that inscribes the surface of each of the respective blades **20**, then M**1**_a_<M**1**_b_, where M**1**_b_ is an inter-blade distance between the inner peripheral blade ends **20**_cb_ in the inter-blade-ring center section **20**_b_ and M**1**_a_ is an inter-blade distance between the inner peripheral blade ends **20**_ca_ in the blade-ring proximate section **20**_a_. That is, the inter-blade distance in the inter-blade-ring center section **20**_b_ is greater than that in the blade-ring proximate section **20**_a_.

Further, the inter-blade distance M**2**_a_ between the outer peripheral blade ends **20**_da_ in the blade-ring proximate section **20**_a_ is the same as the inter-blade distance M**2**_b_ between the outer peripheral blade ends **20**_db_ in the inter-blade-ring center section **20**_b_.

Furthermore, the inter-blade distances M**2**_a_ and M**2**_b_ between the outer peripheral blade ends **20**_da_ and **20**_db_, respectively, are at least formed smaller than the inter-blade distances M**1**_a_ and M**1**_b_ between the inner peripheral blade ends **20**_ca_ and **20**_cb_, respectively.

Note that in FIG. **10**, Ua depicts a blowout flow from the blade-ring proximate section **20**_a_. Furthermore, Ub depicts a blowout flow from the inter-blade-ring center section **20**_b_.

As described above, in Embodiment 1, the blade **20** is divided into plural areas in the fan rotation axis O direction, and both ends adjacent to the rings **8**_b_ are denoted as the blade-ring proximate sections **20**_a_ and the center portion of the blade **20** is denoted as the inter-blade-ring center section **20**_b_. The blade **20** is formed such that the thickness of the inner peripheral blade end **20**_c_ of the blade **20** that is the inner peripheral end of the impeller **8**_a_ is smaller in the inter-blade-ring center section **20**_b_ than in the blade-ring proximate section **20**_a_.

Accordingly, the inter-blade distance M**1**_b_ between the inner peripheral blade ends **20**_cb_ in the inter-blade-ring center section **20**_b_ is greater than the inter-blade distance M**1**_a_ between the inner peripheral blade ends **20**_ca_ in the blade-ring proximate section **20**_a_. Therefore, it is possible to blow out air in the fan-blow-out region such that the velocity of air passing between the blades is lower in the inter-blade-ring center section **20**_b_ than in the blade-ring proximate section **20**_a_.

As a result, it is possible to uniformize the air velocity distribution in the fan-blow-out region in the fan rotation axis O direction, reduce the air flow resistance in the blow-out passage, and reduce power consumption of the fan motor. Hence, energy efficiency can be improved.

Furthermore, since the thickness of the inner peripheral blade ends **20**_ca_ is large in the blade-ring proximate section **20**_a_, the inter-blade distance M**1**_b_ between the inner peripheral blade ends **20**_cb_ is small.

Accordingly, even if a boundary-layer turbulent flow that develops on the surface of the ring **8**_b_ flows in, the flow is accelerated in the blade-ring proximate section **20**_a_ and is blown out to the fan blow out side.

That is, it is possible to reduce noise by reducing the turbulence and the air velocity of the flow flowing into the blade **20**.

Furthermore, in Embodiment 1, the areas between the blade-ring proximate sections **20***a* and the inter-blade-ring center section **20***b* are referred to as the blade connection sections **20***e* and the thickness of the blade **20** in the blade connection sections **20***e* is formed to gradually change in shape from the thickness of the blade-ring proximate sections **20***a* to the thickness of the inter-blade-ring center section **20***b*.

Accordingly, it is possible to blow out air while seamlessly reducing the velocity of air passing between the blades.

As a result, it is possible to uniformize the air velocity distribution in the fan-blow-out region in the fan rotation axis O direction, reduce the air flow resistance in the blow-out passage, and reduce power consumption of the fan motor. Hence, energy efficiency can be improved.

Further, in Embodiment 1, the thickness of the blade **20** in the blade-ring proximate section **20***a* is formed to gradually increase from the outer peripheral blade end **20***da* to the inner peripheral blade end **20***ca*. Furthermore, the thickness of the blade **20** in the inter-blade-ring center section **20***b* is formed to gradually increase from the outer peripheral blade end **20***d* to the middle of the outer peripheral blade end **20***d* and the inner peripheral blade end **20***c* and to gradually decrease from the middle portion to the inner peripheral blade end **20***c*.

Accordingly, even if a boundary-layer turbulent flow that develops on the surface of the ring **8***b* flows in, since the inter-blade distance M**1***a* is small, the turbulence is seamlessly attenuated and is blown out to the fan blow out side. That is, noise can be reduced by reducing the turbulence and the air velocity of the flow flowing into the blade **20**.

Furthermore, the inter-blade-ring center section **20***b* can blow out air while further reducing the velocity of air passing between the blades.

As a result, it is possible to uniformize the air velocity distribution in the fan-blow-out region in the fan rotation axis O direction, reduce the air flow resistance in the blow-out passage, and reduce power consumption of the fan motor. Hence, energy efficiency can be improved.

Further, in Embodiment 1, the blade **20** is formed such that its section orthogonal to the fan rotation axis O is an arc shape, and when the chord center point C**3***a* is referred to as the intersection point between the perpendicular bisector of the chord line, which connects the outer peripheral blade end **20***d* and the inner peripheral blade end **20***c*, and the center of thickness of the blade **20**, then the thickness of the blade **20** in the blade-ring proximate section **20***a* is formed such that: thickness of the outer peripheral blade end **20***d*<thickness at the chord center point C**3***a*<thickness of the inner peripheral blade end **20***c*. Furthermore, the thickness of the blade **20** in the inter-blade-ring center section **20***b* is formed such that: thickness of the outer peripheral blade end **20***d*<the thickness at the chord center point C**3***a*, and, the thickness at the chord center point C**3***a*>thickness of the inner peripheral blade end **20***c*.

Accordingly, even if a boundary-layer turbulent flow that develops on the surface of the ring **8***b* flows in, since the inter-blade distance M**1***a* is small, the turbulence is seamlessly attenuated and is blown out to the fan blow out side. That is, noise can be reduced by reducing the turbulence and the air velocity of the flow flowing into the blade **20**.

Furthermore, the inter-blade-ring center section **20***b* can blow out air while further reducing the velocity of air passing between the blades.

As a result, it is possible to uniformize the air velocity distribution in the fan-blow-out region in the fan rotation axis O direction, reduce the air flow resistance in the blow-out passage, and reduce power consumption of the fan motor. Hence, energy efficiency can be improved.

Further, in Embodiment 1, the arc radius of the blade pressure surface **20***p*, which is the front surface of the blade **20** with respect to the fan rotation direction RO, is formed so as to be smaller than the arc radius of the blade suction pressure surface **20***s*, which is the rear surface of the blade **20** with respect to the fan rotation direction RO, in the blade-ring proximate section **20***a*, and the arc radius of the blade pressure surface **20***p* is formed so as to be larger than the arc radius of the blade suction pressure surface **20***s* in the inter-blade-ring center section **20***b*.

Accordingly, in the inter-blade-ring center section **20***b* where volume of air passing therethrough is large, it is possible to reduce the deflection angle of the flow in the blade pressure surface **20***p*.

Furthermore, in the blade-ring proximate section **20***a* where volume of air passing therethrough is small, it is possible to increase the deflection angle of the flow in the blade pressure surface **20***p*.

That is, as illustrated in FIG. **10**, the blowout flow Ub from the inter-blade-ring center section **20***b* blows out to the guide wall **10** side from the middle of the height direction of the air outlet **3**.

Moreover, the blowout flow Ua from the blade-ring proximate section **20***a* blows out to the stabilizer **9** side and into a portion above the blowout flow Ub from the middle of the height direction of the air outlet **3**.

As a result, in the fan rotation axis O direction, it is possible to blow out air to different directions in the height direction of the air outlet **3**. As such, the high-velocity region is diffused, drift is suppressed, the air velocity distribution is uniformized, and thus, air flow resistance is reduced.

Accordingly, it is possible to lower the air flow resistance in the air passage and reduce the power consumption of the fan motor. Hence, energy efficiency can be improved.

Further, in Embodiment 1, in each area of the blade **20**, the shape of the section orthogonal to the fan rotation axis O is formed such that the shape in each area is the same from the outer peripheral blade end **20***d* to the middle of the outer peripheral blade end **20***d* and the inner peripheral blade end **20***c*. Furthermore, each area is formed so that the shape varies from the middle of the outer peripheral blade end **20***d* and the inner peripheral blade end **20***c* to the inner peripheral blade end **20***c*.

Accordingly, adherence of dust to the blade **20** can be suppressed. That is, if there is, on the outer peripheral side of the impeller **8***a* in the fan rotation axis O direction, a shape-changed portion, such as, for example, waviness or notches in the thickness or the outer peripheral blade end **20***d*, then there are cases in which the floating dust around the fan is stuck in the shape-changed portion when the cross flow fan **8** is activated, becoming a beginning of adhesion and sticking of dust onto the blade **20**. In Embodiment 1, adhesion of dust can be suppressed since the blade **20** from the middle to the inner peripheral blade end **20***c* is formed to vary its shape.

Accordingly, cleanliness of the cross flow fan **8** can be maintained. As a result, a sanitary air-conditioning apparatus can be obtained.

Furthermore, in Embodiment 1, as shown in FIG. **6**, regarding the inter-blade-ring length B in the fan rotation axis O direction, the length Bb of the inter-blade-ring center section **20***b* in the fan rotation axis O direction, each length Ba of the two blade-ring proximate sections **20***a* at both ends in the fan rotation axis O direction, and each length Bc of the two blade connection sections **20***e* in the fan rotation axis O direction hold the relationship of Bb>Ba>Bc.

If the ratio of this length Bb of the inter-blade-ring center section **20***b* to the inter-blade-ring length B is excessively high, then the flow concentrates too much in the inter-blade-ring center section, and if, conversely, the ratio is excessively low, then the noise reduction effect and the energy saving effect cannot be obtained. As such, there is an optimum range.

FIG. **11** is a diagram illustrating the noise value change in relation to a ratio Bb/B of a length Bb of an inter-blade-ring center section to an inter-blade-ring length B, under a constant air volume.

FIG. **12** is a diagram illustrating change in fan motor power consumption in relation to the ratio Bb/B under a constant air volume.

As illustrated in FIG. **11**, when the ratio Bb/B of the blade **20**, which is the ratio of the length Bb of the inter-blade-ring center section **20***b* in the fan rotation axis O direction to the inter-blade-ring length B in the fan rotation axis O direction, is at least between 0.4 and 0.6, then the noise reduction effect can be obtained.

Furthermore, as shown in FIG. **12**, when Bb/B is at least between 0.3 and 0.7, then power consumption of the fan motor can be reduced.

Accordingly, if Bb/B is at least between 0.4 and 0.6, then the noise reduction effect and the fan-motor power-consumption reduction effect can be obtained, and thus, a quiet and high energy saving cross flow fan **8** and air-conditioning apparatus can be obtained.

Embodiment 2

FIG. **13** is a perspective view of a cross flow fan of Embodiment 2 that corresponds to that of FIG. **4** and that is mounted to an air-conditioning apparatus.

FIG. **14** is a cross-sectional view of the blade of FIG. **13** corresponding to that of FIG. **9** taken along the line B-B.

Referring to FIG. **14**, a shape of the blade-ring proximate section **20***a* is shown, as well as a section of the inter-blade-ring center section **20***b* that is a section orthogonal to the fan rotation axis O.

Note that in FIG. **13** and FIG. **14**, components that correspond to those in the above-described Embodiment 1 will be denoted with the same reference numerals. Hereinafter, points different from those of Embodiment 1 described above will be mainly described.

As illustrated in FIG. **13**, the inner peripheral blade end **20***c* in the inter-blade-ring center section **20***b* is formed so as to protrude more to the inner peripheral side of the impeller **8***a* than the blade-ring proximate section **20***a*. That is, it has a convex shape.

Further, as illustrated in FIG. **14**, the camber line Sb in the inter-blade-ring center section **20***b* is identical to the camber lines Sa in the blade-ring proximate sections **20***a*. The camber line Sb protrudes along the extension line of the camber line Sa towards the inner peripheral side of the impeller **8***a*. That is, the arc radius of the center of thickness in the inter-blade-ring center section **20***b* is formed so as to have the same arc radius as the center of thickness in the blade-ring proximate sections **20***a*.

Furthermore, the arc center point C2*a* of the outer peripheral blade end **20***da* in the blade-ring proximate section **20***a* is the same as the arc center point C2*b* of the outer peripheral blade end **20***db* in the inter-blade-ring center section **20***b*.

Further, in FIG. **14**, La is the chord line of the line connecting the arc center point C1*a* of the inner peripheral blade end **20***ca* and the arc center point C2*a* of the outer peripheral blade end **20***da*, in the blade-ring proximate section **20***a*.

Furthermore, Lb is the chord line of the line connecting the arc center point C1*b* of the inner peripheral blade end **20***cb* and the arc center point C2*b* of the outer peripheral blade end **20***db*, in the inter-blade-ring center section **20***b*.

Now, the length of the chord line Lb is formed to be longer than that of the chord line La.

Further, R**01***a* is the radius of a circle that is centered around the fan rotation axis O and that passes through the arc center point C**1***a* of the inner peripheral blade end **20***ca* in the blade-ring proximate section **20***a*.

Further, R**01***b* is the radius of a circle that is centered around the fan rotation axis O and that passes through the arc center point C**1***b* of the inner peripheral blade end **20***cb* in the inter-blade-ring center section **20***b*.

Now, the blade **20** is formed such that: radius R**01***a*>radius R**01***b*.

As above, in Embodiment 2, the inner peripheral blade end **20***c* in the inter-blade-ring center section **20***b* is formed so as to protrude more to the inner peripheral side of the impeller **8***a* than the blade-ring proximate section **20***a*.

Accordingly, the chord length in the inter-blade-ring center section **20***b* (the length of the chord line Lb) becomes longer than the chord length in the blade-ring proximate sections **20***a* (the length of the chord line La), and thus, it is possible to allow the inter-blade-ring center section **20***b* to have a higher static pressure rise than the blade-ring proximate sections **20***a*.

Accordingly, it is possible to generate a pressure gradient from the inter-blade-ring center section **20***b* to each blade-ring proximate section **20***a* on both sides such that the pressure changes from high pressure to low pressure. As a result, it is possible to generate a flow from the inter-blade-ring center section **20***b* to each blade-ring proximate section **20***a*.

In addition to the boundary-layer turbulent flow suppressing effect in the blade-ring proximate sections **20***a* of Embodiment 1 described above, it is possible to suppress the development of the boundary layer at the surface of the ring **8***b* with the flow to the blade-ring proximate sections **20***a* from the inter-blade-ring center section **20***b*; hence, separated turbulent flow on the outlet side of the blade **20** can be further suppressed.

Accordingly, it is possible to further reduce noise, as well as reducing power consumption of the fan motor by increasing the effective air passage and, thus, reducing the air flow resistance between the blades.

Therefore, a cross flow fan **8** and air-conditioning apparatus that are even more quiet and energy saving can be obtained.

INDUSTRIAL APPLICABILITY

Not limited to the above-described air-conditioning apparatus, the cross flow fan of the invention can be effectively utilized in an air cleaner, a humidifier, a dehumidifier, or the like.

REFERENCE SIGNS LIST

1 air-conditioning apparatus body; **1***a* body front; **1***b* body upper portion; **2** upper inlet port; **3** air outlet; **4***a* vertical wind direction vane; **4***b* horizontal wind direction vane **4***b*; **5** filter; **6** front grille; **7** heat exchanger; **8** cross flow fan; **8***a* impeller; **8***b* ring; **8***c* impeller unit; **8***d* fan shaft; **8***e* fan boss; **9** stabilizer; **10** guide wall; **11** room; **11***a* wall; **12** motor; **12***a* motor shaft; **20** blade; **20***a* blade-ring proximate section; **20***b* inter-blade-ring center section; 20c inner peripheral blade end; 20ca inner peripheral blade end at the blade-ring proximate section 20a; 20cb inner peripheral blade end at the inter-blade-ring center section 20b; 20d outer peripheral blade end; 20da peripheral blade end at the blade-ring proximate section 20a; 20db peripheral blade end at the inter-blade-ring center section 20b; 20e blade connection section; 20p blade pressure surface; 20s blade suction pressure surface; B inter-blade-ring length; Ba length of the blade-ring proximate section 20a; Bb length of the inter-blade-ring center section 20b; Bc length of the blade connection section 20e; C1a arc center point of the inner peripheral blade end 20ca in the blade-ring proximate section 20a; C1b arc center point of the inner peripheral blade end 20cb in the inter-blade-ring center section 20b; C2a arc center point of the outer peripheral blade end 20da in the blade-ring proximate section 20a; C2b arc center point of the outer peripheral blade end 20db in the inter-blade-ring center section 20b; C3a chord center point at the blade-ring proximate section 20a; C3a' projected point of the chord center point C3a onto the section taken along the line B-B; E1 suction side flow path; E2 discharge side flow path; F arrow view; La chord line in the blade-ring proximate section 20a; Lb chord line in the inter-blade-ring center section 20b; Mia inter-blade distance between the inner peripheral blade ends 20ca in the blade-ring proximate section 20a; M1b inter-blade distance between the inner peripheral blade ends 20cb in the inter-blade-ring center section 20b; M2a inter-blade distance between the outer peripheral blade ends 20da in the blade-ring proximate section 20a; M2b inter-blade distance between the outer peripheral blade ends 20db in the inter-blade-ring center section 20b; O fan rotation axis; RO fan rotation direction; R01a radius of a circle that is centered around the fan rotation axis O and that passes through the arc center point C1a of the inner peripheral blade end 20ca in the blade-ring proximate section 20a; R01b radius of a circle that is centered around the fan rotation axis O and that passes through the arc center point C1a of the inner peripheral blade end 20ca in the inter-blade-ring center section 20b; R02a radius of a circle that is centered around the fan rotation axis O and that passes through the arc center point C2a of the outer peripheral blade end 20da in the blade-ring proximate section 20a; R02b radius of a circle that is centered around the fan rotation axis O and that passes through the arc center point C2a of the outer peripheral blade end 20da in the inter-blade-ring center section 20b; Ra1 arc radius of the blade pressure surface 20p in the blade-ring proximate section 20a; Ra2 arc radius of the blade suction pressure surface 20s in the blade-ring proximate section 20a; Ra3 arc radius of the camber line Sa in the blade-ring proximate section 20a, Rb1 arc radius of the blade pressure surface 20p in the inter-blade-ring center section 20b; Rb2 arc radius of the blade suction pressure surface 20s in the inter-blade-ring center section 20b; Rb3 arc radius of the camber line Sb in the inter-blade-ring center section 20b; Sa camber line in the blade-ring proximate sections 20a; Sb camber line in the inter-blade-ring center section 20b; Ua blowout flow from the blade-ring proximate section 20a; Ub blowout flow from the inter-blade-ring center section 20b; t1a thickness at the arc center point C1a of the inner peripheral blade end 20ca in the blade-ring proximate section 20a; t1b thickness at the arc center point C1b of the inner peripheral blade end 20cb in the inter-blade-ring center section 20b; t2a thickness at an arc center point C2a of the outer peripheral blade end 20da in the blade-ring proximate section 20a; t2b thickness at an arc center point C2b of the outer peripheral blade end 20db in the inter-blade-ring center section 20b; t3a thickness at the chord center point C3a in the blade-ring proximate section 20a.

The invention claimed is:

1. A cross flow fan, comprising:
an impeller including,
at least two support plates arranged with intervals in a rotation axis direction, and
a plurality of blades arranged between correlated support plates, the blades being arranged with intervals in a circumferential direction of the support plates, wherein
each blade between the support plates is divided into a plurality of areas in the rotation axis direction such that both ends adjacent to the support plates are a first area and a center portion of the blade is a second area,
a thickness of an inner peripheral blade end is formed such that the second area is smaller in thickness than the first area,
an area between the first area and the second area is a third area, and
a thickness of the blade in the third area is formed to gradually change in shape from a thickness of the blade in the first area to a thickness of the blade in the second area.

2. The cross flow fan of claim 1, wherein a thickness of the blade in the first area is formed so as to become gradually thicker from an outer peripheral blade end that is an end of the blade on an outer-circumferential side of the impeller to the inner peripheral blade end.

3. The cross flow fan of claim 1, wherein,
the thickness of the blade in the second area is formed so as to become gradually thinner to an inner peripheral blade end that is an end of the blade on an inner-circumferential side of the impeller after the thickness of the blade in the second area is formed so as to become gradually thicker from an outer peripheral blade end that is an end of the blade on an outer-circumferential side of the impeller to the inner peripheral blade end.

4. The cross flow fan of claim 1, wherein the thickness of the blade in the second area is formed so as to become gradually thicker from an outer peripheral blade end to the middle of the outer peripheral blade end and an inner peripheral blade end and is formed so as to become gradually thinner from the middle to the inner peripheral blade end.

5. The cross flow fan of claim 1, wherein,
each blade is formed such that a section orthogonal to the rotation axis is an arc shape, and
when an intersection point between a perpendicular bisector of a chord line connecting an outer peripheral blade end and the inner peripheral blade end, and a center of thickness of the blade is referred to as a chord center point,
the thickness of each blade in the first area is formed such that: the thickness of the outer peripheral blade end<the thickness at the chord center point<thickness of the inner peripheral blade end, and
the thickness of each blade in the second area is formed such that: thickness of the outer peripheral blade end<the thickness at the chord center point, and, the thickness at the chord center point>thickness of the inner peripheral blade end.

6. The cross flow fan of claim 1, wherein,
each blade is formed such that the section orthogonal to the rotation axis is the arc shape,
in the first area, an arc radius of a blade pressure surface that is a front surface with respect to a rotation direction of the blades is formed so as to be smaller than an arc

radius of a blade suction pressure surface that is a rear surface with respect to the rotation direction of the blades, and

in the second area, the arc radius of the blade pressure surface is formed so as to be larger than the arc radius of the blade suction pressure surface.

7. The cross flow fan of claim **1**, wherein

in each area of the blade, a shape of a section orthogonal to the rotation axis is formed such that

the shape in each area is identical from an outer peripheral blade end to the middle of the outer peripheral blade end and an inner peripheral blade end, and

the shape in each area varies from the middle of the outer peripheral blade end and the inner peripheral blade end to the inner peripheral blade end.

8. The cross flow fan of claim **1**, wherein the inner peripheral blade end in the second area is formed so as to protrude more to an outer-circumferential side of the impeller than the first area.

9. The cross flow fan of claim **8**, wherein,

each blade is formed such that the section orthogonal to the rotation axis is the arc shape, and

an arc radius of a center of thickness in the second area is formed so as to have an arc radius equivalent to a center of thickness in the first area.

10. The cross flow fan of claim **1**, wherein a ratio (Bb/B) of a length (Bb) of the second area in the rotation axis direction to a total length (B) of the blade in the rotation axis direction is formed to be between 0.4 and 0.6.

11. The cross flow fan of claim **1**, wherein the ratio (Bb/B) of the length (Bb) of the second area in the rotation axis direction to the total length (B) of the blade in the rotation axis direction is formed to be between 0.3 and 0.7.

12. An air-conditioning apparatus, comprising:

a cross flow fan, including,

an impeller having,

at least two support plates arranged with intervals in a rotation axis direction, and

a plurality of blades arranged between correlated support plates, the blades being arranged with intervals in a circumferential direction of the support plates, wherein

each blade between the support plates is divided into a plurality of areas in the rotation axis direction such that both ends adjacent to the support plates are a first area and a center portion of the blade is a second area,

a thickness of an inner peripheral blade end is formed such that the second area is smaller in thickness than the first area,

an area between the first area and the second area is a third area, and

a thickness of the blade in the third area is formed to gradually change in shape from a thickness of the blade in the first area to a thickness of the blade in the second area; and

a heat exchanger disposed in a suction-side passage formed by the cross flow fan, the heat exchanger being configured to exchange heat with sucked-in air.

13. The air-conditioning apparatus of claim **12**, wherein the thickness of the blade in the first area is formed so as to become gradually thicker from an outer peripheral blade end that is an end of the blade on an outer-circumferential side of the impeller to the inner peripheral blade end.

14. The air-conditioning apparatus of claim **12**, wherein the thickness of the blade in the second area is formed so as to become gradually thinner to an inner peripheral blade end that is an end of the blade on an inner-circumferential side of the impeller after the thickness of the blade in the second area is formed so as to become gradually thicker from an outer peripheral blade end that is an end of the blade on an outer-circumferential side of the impeller to the inner peripheral blade end.

15. The air-conditioning apparatus of claim **12**, wherein the thickness of the blade in the second area is formed so as to become gradually thicker from an outer peripheral blade end to the middle of the outer peripheral blade end and the inner peripheral blade end and is formed so as to become gradually thinner from the middle to the inner peripheral blade end.

16. The air-conditioning apparatus of claim **12**, wherein

each blade is formed such that a section orthogonal to the rotation axis is an arc shape, and

when an intersection point between the perpendicular bisector of a chord line connecting an outer peripheral blade end and the inner peripheral blade end, and a center of thickness of the blade is referred to as a chord center point,

the thickness of each blade in the first area is formed such that: the thickness of the outer peripheral blade end<the thickness at the chord center point<thickness of the inner peripheral blade end, and

the thickness of each blade in the second area is formed such that: thickness of the outer peripheral blade end<the thickness at the chord center point, and, the thickness at the chord center point>thickness of the inner peripheral blade end.

17. The air-conditioning apparatus of claim **12**, wherein

each blade is formed such that a section orthogonal to the rotation axis is the arc shape,

in the first area, an arc radius of a blade pressure surface that is a front surface with respect to a rotation direction of the blades is formed so as to be smaller than an arc radius of a blade suction pressure surface that is a rear surface with respect to the rotation direction of the blades, and

in the second area, the arc radius of the blade pressure surface is formed so as to be larger than the arc radius of the blade suction pressure surface.

18. The air-conditioning apparatus of claim **12**, wherein

in each area of the blade, a shape of the section orthogonal to the rotation axis is formed such that

the shape in each area is identical from an outer peripheral blade end to the middle of the outer peripheral blade end and the inner peripheral blade end, and

the shape in each area varies from the middle of the outer peripheral blade end and the inner peripheral blade end to the inner peripheral blade end.

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